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Determination of Alpha, Beta and Gamma Cellulose in Pulp  
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## METHODS OF TEST FOR PULP

### **PART III DETERMINATION OF ALPHA, BETA AND GAMMA CELLULOSE IN PULP**

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**BUREAU OF INDIAN STANDARDS**  
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG  
NEW DELHI 110002

# Indian Standard

## METHODS OF TEST FOR PULP

### PART III DETERMINATION OF ALPHA, BETA AND GAMMA CELLULOSE IN PULP

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(Continued on page 2)

(Continued from page 1)

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*Indian Standard***METHODS OF TEST FOR PULP****PART III DETERMINATION OF ALPHA, BETA AND GAMMA CELLULOSE IN PULP****0. FOREWORD**

**0.1** This Indian Standard (Part III) was adopted by the Indian Standards Institution on 26 June 1971, after the draft finalized by the Paper Sectional Committee had been approved by the Chemical Division Council.

**0.2** For obtaining good quality of paper, it is essential that the pulp which goes into the manufacture of paper is properly cooked and bleached. Formulation of this standard had been taken up in order to guide the people working in pulp and paper mills for the methods to be adopted for pulp analysis.

**0.3** In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS:2-1960\*.

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**1. SCOPE**

**1.1** This standard (Part III) prescribes the method of test for determination of alpha, beta and gamma cellulose in pulp.

**2. QUALITY OF REAGENTS**

**2.1** Unless otherwise specified, pure chemicals and distilled water (*see* IS: 1070-1960†) freshly boiled and cooled, shall be employed in the tests.

**NOTE**—‘Pure chemicals’ shall mean chemicals that do not contain impurities which affect the results of analysis.

**3. GENERAL**

**3.1** Plant cellulose is not homogeneous in chemical composition. The residual high molecular weight fraction which is left behind when a mixture of pulp and 8·3 percent sodium hydroxide solution is filtered after the

\*Rules for rounding off numerical values (*revised*).

†Specification for water, distilled quality (*revised*).

fibres have been initially swollen in a 17·5 percent sodium hydroxide solution under specified conditions, has been defined as alpha cellulose. The filtrate contains the short chain material and consists of beta and gamma celluloses. The fraction of cellulose which is capable of being reprecipitated by means of acid from the above solution is known as beta cellulose. The percentage of gamma cellulose may be obtained by subtracting the sum of alpha and beta celluloses from 100.

## **4. DETERMINATION OF ALPHA CELLULOSE**

### **4.1 Reagents**

**4.1.1 Sodium Hydroxide** —  $17\cdot5 \pm 0\cdot1$  percent by weight.

**4.1.2 Sodium Hydroxide** — 8·3 percent by weight.

### **4.2 Procedure**

**4.2.1** Take a representative sample of the pulp and shred it by hand (not grind). Keep one portion for determination of dry content. From the other portion weigh accurately a sample equivalent to approximately 3·0 g of the moisture-free pulp. Transfer the same to a 250-ml beaker kept in a water-bath maintained at  $20\cdot0 \pm 0\cdot2^{\circ}\text{C}$ . Take 75 ml of 17·5 percent sodium hydroxide solution in a graduated cylinder and keep at  $20^{\circ}\text{C}$  in the water-bath. Wet the pulp sample with 15 ml of this solution and disintegrate it for one minute with the flat end of a glass rod; add 10 ml more of the sodium hydroxide solution to the pulp and mix for 45 seconds; and add 10 ml of sodium hydroxide solution and mix for 15 seconds. After the addition of 35 ml of caustic soda solution and disintegration, the pulp should be free from lumps. Stir and allow the mixture to stand in the water-bath for 3 more minutes. Add another 10 ml of sodium hydroxide solution and mix for 10 minutes more while adding the remaining 30 ml of caustic soda solution in three instalments of 10 ml each at the intervals of 2·5, 5·0 and 7·5 minutes.

**4.2.2** Leave the beaker with the contents in the water-bath for another 30 minutes. Now add 100 ml of distilled water at  $20^{\circ}\text{C}$ , mix thoroughly with a glass rod and leave the diluted mixture in the water-bath for 30 minutes more. Filter the contents on a tared gooch crucible by suction and collect the filtrate in a separate beaker. In case suspended fibres are noticed in the filterate, pass it successively through the mat in the crucible till it is free from cellulose fibres. Rinse the beaker and residue with 25 ml of 8·3 percent sodium hydroxide solution at  $20^{\circ}\text{C}$  and transfer all the fibres to the crucible. When applying suction, the pulp pad should be kept covered with solution to prevent air being drawn through. Wash the residue with five 50-ml portions of distilled water at  $20^{\circ}\text{C}$ . Keep the filtrate aside for the determination of beta and gamma cellulose.

**4.2.3** Place the crucible on another suction flask. Wash the residue in the crucible with 400 ml of distilled water at 20°C and subsequently with 40 ml of 10 percent acetic acid solution at 20°C. Allow a soaking period of 5 minutes before applying the suction. Wash the residue again with distilled water till it is free from acetic acid as indicated by litmus paper. Dry the crucible in an oven at 103 ± 2°C and transfer the contents to a weighing bottle. Dry it to a constant weight.

**4.3 Calculation** — Carry out two determinations and calculate the percentage of alpha cellulose as follows:

$$x = \frac{100 a}{m}$$

where

$x$  = alpha cellulose percentage by weight,

$a$  = weight of precipitate in g, and

$m$  = weight of pulp in g calculated on oven-dry basis.

Report the result as a mean of two determinations to two places of decimal. The results should check within 0·2 percent.

## 5. DETERMINATION OF BETA CELLULOSE

### 5.1 Reagents

#### 5.1.1 Acetic Acid

**5.2 Procedure** — Transfer the filtrate and washings from alpha cellulose determination to a 500-ml flask and make up the volume to the mark with distilled water. Shake well and pipette out 100 ml of the solution in a 250-ml beaker. Precipitate the beta cellulose by gradually adding acetic acid keeping the solution well stirred with a glass rod. Heat the mixture on a water-bath for 30 minutes to coagulate the precipitate. Filter and wash with hot distilled water till free from acid. Set aside the filtrate for gamma cellulose determination. Dry at 103 ± 2°C in an air oven and weigh. Ignite the material so that allowance can be made for any ash.

**5.3 Calculation** — The weight of beta cellulose in 100 ml of solution being known, report it on the basis of 100 g of oven-dry pulp sample.

## 6. DETERMINATION OF GAMMA CELLULOSE

### 6.1 Reagents

#### 6.1.1 Potassium Dichromate — 9 percent by weight.

#### 6.1.2 Sulphuric Acid — specific gravity 1·84.

**6.1.3 Ferrous Ammonium Sulphate Solution**— Make by dissolving 159·9 g of ferrous ammonium sulphate and add 5 ml of 10 percent sulphuric acid in one litre.

**6.2 Procedure**— Take 50 ml of the filtrate from beta cellulose determination and add 8 ml of 9 percent solution of potassium dichromate followed by 50 ml of sulphuric acid. Boil the mixture for exactly 3·5 minutes. Let it cool for 30 minutes. Titrate with ferrous ammonium sulphate solution using potassium ferricyanide as an external indicator.

1 g of  $K_2Cr_2O_7$  = 0·1375 of gamma cellulose.

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